McMaster University | HEALTH FORUM

Living Evidence Profile

Identifying features and impacts of public health strategies that can be used to prevent, reduce, and/or mitigate avian influenza spillover to humans

17 July 2024

[MHF product code: LEP 8.3] *Note that this product was previously labelled as rapid evidence profile #64 but has since been changed to a living evidence profile.

Box 1: Evidence and other types of information

+ Global evidence drawn upon

Evidence syntheses selected based on relevance, quality, and recency of search

- Forms of domestic evidence used (🍁 = Canadian)

Evaluation

- Other types of information used

Jurisdictional scan

10 countries (AU, BR, CN, FR, JP, KH, NZ, SG, UK, US), in addition to international organizations and Canadian provinces and territories

*** Additional notable features**

Prepared in three business days using an 'all hands on deck' approach

Context

- Avian influenza is commonly found in birds, but it can also infect non-human mammals (e.g., cats, foxes, bears) and humans.
- Human infections typically occur after exposure through close contact with infected birds or in highly contaminated environments like poultry farms and live animal markets.
- Recent cases of H5 avian influenza viruses (clades 2.3.4.4b and 2.3.2.1c) have emerged or re-emerged in poultry, wild birds, and wildlife, and on 25 March 2024, a multi-state outbreak of highly pathogenic avian influenza A(H5N1) in dairy cows was reported in the United States, reflective of the continued spread of clade 2.3.4.4b viruses that entered the U.S. in late 2021.(1; 2)
- Given these recent outbreaks in poultry and U.S. dairy cattle, as well as recent reports of human cases of infection (3), it is important to identify effective upstream and downstream public health strategies (particularly those using a One Health approach that mobilizes multiple sectors of health in a unified response to health threats) to prevent, reduce, and/or mitigate the risk of avian influenza spillover into humans.
- This living evidence profile (LEP) was originally requested to inform initial deliberations about such public health strategies and was therefore focused on identifying existing evidence syntheses where single studies were identified and synthesized.
- This update to the LEP includes: 1) an update of the previous literature search from LEP 8.2 for evidence syntheses (including any single studies that we could identify about transmission involving cattle or other livestock, as well as transmission risk to livestock workers, given the recent outbreak in the U.S.); and 2) an update of the jurisdictional scan from LEP 8.2 to provide more detailed insights from other countries and Canadian provinces and territories on public health strategies related to avian influenza.

Question

- What are the features and impacts of public health strategies, particularly those that adopt a One Health approach, that can contribute to preventing, reducing, and/or mitigating the risk of avian influenza spillover into humans?

High-level summary of key findings

- We identified one new evidence synthesis, five single studies, and five pre-print studies related to public health strategies to prevent, reduce, and/or mitigate avian influenza spillover to humans.
  - With these newly identified evidence documents, we have included a total of 27 evidence documents (13 evidence syntheses and 14 single studies and pre-prints).
- Most of the new evidence focused on non-pharmaceutical measures to prevent avian influenza infection, specifically safe food handling procedures, the use of protective equipment for poultry and dairy farm workers, and case and contact management to mitigate transmission.
- The remaining evidence explored avian influenza vaccine development and efficacy rates against mortality in poultry and also surveillance and reporting strategies (e.g., wastewater testing).
- Our jurisdictional scan of select countries (Australia, Brazil, Cambodia, China, France, Japan, New Zealand, Singapore, United Kingdom, and United States), international organizations (World Health Organization (WHO), Pan American Health Organization (PAHO), World Organisation for Animal Health (WOAH), European Centre for Disease Prevention and Control (ECDC), and Food and Agriculture Organization (FAO)), and Canadian provinces and territories identified any new publicly available information published between 13 May and 15 July 2024 about public health strategies that can be used to prevent, reduce and/or mitigate avian influenza spillover to humans.
- The WOAH and the WHO continue to monitor the prevalence of avian influenza cases in animals and humans globally and to provide recommendations for people in contact with sick, confirmed, or suspected infected animals or contaminated environments.
- Most recently, PAHO provided specific guidance on sample collection in humans and testing, and the ECDC recommended

Box 2: Approach and supporting materials

We identified evidence addressing the question by searching ACCESSSS, Health Systems Evidence, Health Evidence, and PubMed for full evidence syntheses (or synthesis-derived products such as overviews of evidence syntheses) and protocols for evidence syntheses. These searches were last conducted on 8 July 2024 and were not limited by publication date except in PubMed, which was limited to literature published from the last five years (2019 onwards). We also conducted a search for single studies in PubMed and the USDA National Agricultural Library relevant to dairy cattle, other non-human mammals (including ruminants), transmission associated with dairy products, and risk to livestock. In addition, on 8 July 2024 we updated our original search of MedRxiv and BioRxiv (from 1 January 2024 to 13 May 2024) for pre-print articles. The search strategies used are included in Appendix 1.

For LEP 8.3, we hand searched government and stakeholder websites of other select countries (Australia, Brazil, Cambodia, China, France, Japan, New Zealand, Singapore, United Kingdom, and Unites States), international organizations (WHO, PAHO, WOAH, ECDC, and FAO), and Canadian provinces and territories to identify any publicly available information published between 13 May and 15 July 2024. A full list of sources is included in Appendix 6.

In contrast to synthesis methods that provide an in-depth understanding of the evidence, this profile focuses on providing an overview and key insights from relevant documents. Note that the timing, frequency, and scope of future updates of this LEP will be determined in collaboration with the requestor.

A separate appendix document includes:
1) methodological details (Appendix 1)
2) detailed findings about each identified evidence synthesis (Appendix 2)
3) detailed findings about other types of documents (Appendix 3)
4) details about experiences identified in international organizations and other countries (Appendix 4)
5) details about experiences in Canadian provinces and territories (Appendix 5)
6) key list of sources used for jurisdictional scans (Appendix 6)
7) documents that were excluded in the final stages of review (Appendix 7).

This living evidence profile was prepared in the equivalent of a three-business-day 'full court press' by all involved staff.

lowering the threshold for testing for avian influenza in humans (e.g., testing for avian influenza among individuals hospitalized for influenza).

- The Food and Drug Administration (FDA) in the U.S. has continued a stepwise approach to scientific analysis of commercial milk safety in order to test the efficacy of the pasteurized milk ordinance on the elimination of known pathogens in the milk supply, and recently issued an open letter to state regulators asking them to implement a surveillance testing program state to identify the presence of A(H5N1) virus in dairy herds.
- Border control measures were implemented by Singapore, Japan, and Canada in response to cases of avian influenza in birds and livestock in recent months, and an A(H5N1) vaccination plan for farmed ducks has been implemented by France as a preventive measure.
- The Canadian Food Inspection Agency (CFIA) in collaboration with Health Canada and the Public Health Agency of Canada (PHAC) has been proactively testing commercial milk samples across Canada to detect fragments of the virus, and as of 16 July 2024, all tested samples have been negative for fragments of highly pathogenic avian influenza (HPAI) A(H5N1).
- The Canadian Wildlife Health Cooperative (CWHC), CFIA, and Environment and Climate Change Canada (ECCC) maintain a dashboard that displays suspected and confirmed cased of HPAI in wildlife in Canada that can be filtered by province and species.
- Most provincial and territorial governments provide non-pharmaceutical recommendations for those exposed to or handling domestic or wild birds or other wildlife and those living in or having travelled to an area with A(H5N1) in alignment with the CFIA's National Biosecurity Standards.
- Information for the public about the aetiology, diagnosis, treatment, prevention, control, surveillance, and management of avian influenza continues to be available and updated on the public health websites of Canadian provinces and territories.

Framework to organize what we looked for

- Public health strategies
  - Information and education provision
  - Non-pharmaceutical measures to prevent infection
    - Avoiding sources of exposure (e.g., reducing contact with infectious birds, animals, or environments)
    - Using personal protective equipment (e.g., masks, gloves)
    - Washing hands
    - Physical distancing
    - Following safe food handling procedures and recommended cooking temperatures
    - Farm and market biosecurity measures (e.g., ventilation, controlled access, cleaning and disinfection practices)
  - Non-pharmaceutical measures to control the spread of infections
    - Case and contact management
    - Isolation and quarantine
    - Border-control measures
  - Pharmaceutical measures used as part of public health strategies
    - Vaccinations (in animals)
    - Vaccinations (in humans)
    - Antiviral medications
  - Surveillance and reporting
- Priority populations
  - Groups at higher risk of exposure
    - Working on a commercial poultry farm (e.g., producers), including seasonal/migrant workers
    - Working with non-commercial or backyard flocks
    - Livestock farm worker/small herd owner
    - Breeding and handling birds (e.g., dealer, breeder of exotics, falconry, racing pigeons)

        - Hunting and trapping wild birds and mammals (e.g., Indigenous harvesters)
        - Working with live or recently killed poultry, cattle, or other livestock (e.g., butcher, processing plant worker, poultry culler)
        - Working with unpasteurized milk products (e.g., milk processing plant worker, cheesemaker)
        - Veterinarians, veterinary staff
        - Working with wild birds and/or mammals for healthcare, research, and conservation (e.g., laboratory workers, researchers, biologists, wildlife rehabilitators, persons permitted to perform bird branding, capturing, sampling, removal, restoration)
        - Working with non-human mammals that commonly eat wild birds
        - Working or visiting live bird or mammal markets
        - Working with or caretaking of animals that regularly interact with wild birds (e.g., caretakers, pets, guardian dogs, hunting dogs, mink/fur animal farmer)
        - Working in healthcare settings and other contacts of cases (if human-to-human transmission starts)
    - Other equity considerations
- Outcomes
    - Reduction in risk of exposure
    - Zoonotic infections
    - Human-to-human infections
    - Health-related outcomes for individuals infected

What we found

Key findings from evidence documents

In this update we identified one new evidence synthesis, five single studies, and five pre-print studies related to public health strategies to prevent, reduce, and/or mitigate avian influenza spillover to humans. With these newly identified evidence documents, we have included a total of 27 evidence documents (13 evidence syntheses and 14 single studies and pre-prints).

Most of the new evidence focused on non-pharmaceutical measures to prevent avian influenza infection as well as surveillance and reporting strategies. New information from this update has been highlighted in the summary below.

Information and education provision

In terms of information and education-related public health strategies, a medium-quality evidence synthesis (low relevance) that focused on front-line healthcare workers found that infection training for those who are involved in endotracheal intubations can significantly reduce their risk of infection from respiratory viruses.(4) Using a systems-level approach, another medium-quality evidence synthesis (medium relevance) highlighted the need for sharing of production and trade data between private and public sectors within commercial poultry networks to facilitate data access and inform policies that can support mitigation strategies for the global spread of avian influenza.(5) We did not identify any new evidence on information and education-related public health strategies.

Non-pharmaceutical measures to prevent infection

In this update, we identified four single studies and three pre-print studies that focused on safe food handling procedures, protective equipment, and case and contact management. Pasteurization of raw dairy products to inactivate the avian influenza A(H5N1) virus was assessed in two single studies and two pre-print studies conducted in the U.S., all of which found pasteurization to be an effective food safety measure to inactivate the virus and prevent infection.(6-9) Another single study concluded that the risk of human infection with avian influenza virus from contaminated beef products is negligible when cooked to the U.S. Department of Agriculture (USDA) Food Safety and Inspection Service (FSIS) recommended a minimum internal temperature for ground beef of 71.1°C

(average cooking time of 24 minutes).(10) One pre-print study assessing milking equipment surfaces found that A(H5N1) avian influenza virus remained infectious in unpasteurized milk on the stainless steel and rubber inflation lining of milking equipment for at least one hour, highlighting the need for dairy farm workers to wear personal protective equipment when handling unpasteurized milk.(11) In terms of case and contact management strategies, one single study found that seasonal, temporary, and permanent live poultry market closures were the most effective intervention implemented in Guangdong province, China to reduce human transmission of A(H7N9) influenza when it emerged between 2013 and 2017.(12) While the intervention was not used to mitigate transmission of A(H5N1) influenza specifically in this case, live poultry market closures has been shown to be an effective public health strategy in response to avian influenza outbreaks.(13)

In previous versions of this LEP, several non-pharmaceutical measures to prevent infection with avian influenza were identified, including using personal protective equipment, physical distancing, and farm and market biosecurity measures. Personal protective measures (e.g., gloves, gowns, surgical masks, N95 respirators) for front-line healthcare workers were found to be effective, and school closures were identified as a strategy to prevent the spread of A(H5N1) in Australia, according to a few low relevance evidence syntheses.(4; 14; 15) One medium-quality evidence synthesis identified live poultry market interventions including quarantine access systems, physically separating poultry from different sources, disinfection and decontamination, daily cleaning, rest days, and live poultry market closures. These interventions supported a decrease in incidence of avian influenza viruses at live poultry market settings.(13)

Pharmaceutical measures used as part of public health strategies

Three evidence syntheses (including one newly identified medium-quality evidence synthesis) focused on vaccinations for animals as a public health strategy against avian influenza. Similar to findings in the evidence syntheses included in previous versions of this LEP, the newly identified medium-quality evidence synthesis found that HPAI vaccines (sub-types not specified), including inactivated and recombinant types, demonstrated high efficacy rates against mortality in poultry, with inactivated vaccines demonstrating higher effectiveness against homologous strains when compared to heterogenous strains.(16) The other two medium-quality evidence syntheses also focused on vaccinations in chickens. One of the evidence syntheses described that both inactivated and recombinant fowlpox virus expressing A(H5) vaccines (for A(H5N1) and A(H5N2)) were efficacious in protecting chickens from morbidity and mortality.(23) The other evidence synthesis indicated that recombinant herpesvirus of turkeys (rHVT) and inactivated replicating viral-vectored vaccines offered advantages to induce broader immunity as they were more tolerant of the variation in the hemagglutinin 1 domain.(24)

Vaccination in humans has also been identified as a pharmaceutical measure used as part of public health strategies against avian influenza. A newly identified pre-print study explored gaps in HPAI vaccine development (sub-types not specified) between 2010–2021 and found only 20 patents for universal avian influenza vaccines and all were still in the early stage of development.(17) When published, this study will identify critical barriers in developing avian influenza vaccines and highlight the urgent need for an effective global model for vaccine preparedness. In previous versions of this LEP, we noted that the Andalusian Agency for Health Technology Assessment reported in a medium-quality evidence synthesis from 2010 that an inactivated split-virion formulation of the A(H5N1) influenza vaccine, which includes a low antigen dose and an oil-in-water emulsion-based adjuvant, had a favourable safety profile and immunogenicity.(18) This finding was supported by another medium-quality evidence synthesis that reported that two doses of 7.5µg of oil-in-water emulsion-adjuvanted A(H5N1) vaccine induced a robust antibody response and was well tolerated among older adults.(19) We also identified a low-quality evidence synthesis that found reduced responses to A(H5N1) influenza vaccination in individuals who had received the seasonal influenza vaccine.(20) Additional research is needed to better understand the reduced immune responses. A newly identified pre-print study highlighted that the delivery of multivalent influenza vaccines from self-assembled, injectable polymer-nanoparticle (PNP) hydrogels induced consistent, rapid and potent humoral immune responses against both heterologous and homologous virus subtypes, including A(H5N1).(21) This finding demonstrates that the use of PNP hydrogels with influenza vaccines can be an effective strategy for generating lasting immunity to influenza.

Lastly, we identified one medium-quality evidence synthesis that concluded that adjuvanted A(H7N9) vaccines for humans were immunogenic and safe in healthy individuals.(22)

Finally, one rapid review explored evidence on the use of convalescent plasma (CP) as a passive immunotherapy treatment against avian influenza (A(H5N1) in humans and found that CP treatment given prior to infection was more efficacious than treatment after infection.(25) However, given concerns about infectivity of potential CP donors and the lack of historical studies on A(H5N1) virus isolation from CP, it is likely that efforts to use CP in treatment will be limited by a lack of pathogen reduction technologies.

Surveillance and reporting

Public health surveillance of avian influenza viruses was the focus of one single study and one pre-print study identified in this update. In the pre-print study, wastewater treatment works across Northern Ireland between August and December 2022 was used to detect a variety of influenza virus subtypes and lineages, including of avian and human influenza A virus, including strains of H5N1 clade 2.3.4.4b, reinforcing findings from existing evidence that wastewater monitoring is a potentially useful surveillance tool for detecting avian influenza.(26) The other single study conducted surveillance of avian influenza subtypes in New York City by performing whole-genome sequencing of samples from four different bird species and detected multiple H5N1 genotypes.(27) The study highlighted that surveillance systems to monitor A(H5N1) virus spread at the animal-human interface in urban areas are lacking despite the high-density population of humans and pets in urban areas, and called for improvements in surveillance efforts in urban cities and high-density populations.

In the previous version of this LEP (LEP 8.2), three pre-print studies identified were focused on surveillance and reporting public health strategies. Two of the studies explored the use of wastewater monitoring following the recent emergence of avian influenza A(H5N1) in dairy cattle in the United States. In one study, researchers used an agnostic, hybrid-capture sequencing approach and detected avian influenza subtype A(H5N1) in wastewater in nine Texas cities between 4 March and 25 April 2024, with the best sequencing reads aligning to clade 2.3.4.4b.(28) In the other study, researchers developed an RT-PCR assay for the A(H5) marker and used it as part of a wastewater monitoring strategy to detect the A(H5) gene in samples from three wastewater plants in the U.S. that were tested in the spring of 2024.(29) At two of the U.S. plants tested, researchers discovered that discharges from animal waste and milk byproducts were permitted to discharge into the sewer system, highlighting the need to consider agricultural and industrial inputs into waste. Finally, researchers of the third study used a probabilistic framework to determine that novel influenza virus cases in the United States are likely to be detected using the existing healthcare surveillance strategies in the U.S. for community and healthcare settings, with the efficiency of the testing setting being directly impacted by the severity of disease in the setting.(31)

Gaps in existing evidence documents

This LEP update included evidence that addressed some of the previous gaps in the literature about public health strategies related to non-pharmaceutical measures to control the spread of infections, but there are still a limited number of highly relevant evidence documents. As the response to avian influenza outbreaks around the world evolves, future studies will need to assess emerging and ongoing public health strategies to prevent the spread of avian influenza in animals and transmission to humans, as well as evaluate their impact and effectiveness.

Key findings from our jurisdictional scan

We originally conducted a jurisdictional scan of select countries (Australia, Brazil, China, Cambodia, France, Japan, New Zealand, Singapore, United Kingdom, and Unites States), international organizations (WHO, PAHO, WOAH, ECDC, and FAO), and Canadian provinces and territories to identify any relevant publicly available information published since 1 February 2024 about public health strategies that can be used to prevent, reduce and/or mitigate avian influenza spillover to humans. We incorporated and highlighted new findings from this LEP version's

updated scan of publicly available information published between 13 May and 15 July 2024 into the narrative summaries below.

International jurisdictions

Information and education provision

In terms of information and education, most international jurisdictions provide information to the public about the etiology, diagnosis, treatment, prevention, control, and surveillance and management of avian influenza on their public health websites. Some jurisdictions, such as Australia, have used fact sheets to update the public on safety precautions for avian influenza, while Health New Zealand Te Whatu Ora offers a control manual for managing HPAI for public health professionals. In Cambodia, the government uses their national Facebook page and telegram channel to communicate with the public about avian influenza outbreaks.

Non-pharmaceutical measures to prevent infection

The WOAH and WHO provide recommendations for people in contact with sick or suspected infected animals, including hand hygiene, using personal protective equipment, avoiding the use and consumption of raw milk products, and implementing strict biosecurity measures in livestock holdings. These measures are echoed by ministries of health in international jurisdictions, including Cambodia, Singapore, the Health Commission of Guangdong Province in China, the U.K., and the U.S. Specific recommendations have been made for farmers, poultry and backyard bird flock owners in the U.S. by the Centers for Disease Control and Prevention (CDC), including that farmers should receive training in wearing, putting on, and taking off personal protective equipment.

Non-pharmaceutical measures to control spread

In terms of case and contact management internationally, all member states under the International Health Regulations (2005) are required to notify the WHO immediately of any laboratory-confirmed case of a recent human avian influenza infection. Animal cases should also be reported to the WOAH through the World Animal Health Information System and genetic sequences should be shared in publicly available databases. PAHO's most recent epidemiological update on 5 June 2024 provided specific guidance on sample collection in humans with nasopharyngeal swabbing as the optimal collection method as well as details about sample flow, laboratory testing algorithm, shipment of samples, case investigation, and notification of a human case. In two reports from 8 July 2024 and 20 June 2024, the ECDC recommended lowering the threshold for testing for avian influenza in humans (e.g., testing for avian influenza among individuals hospitalized for influenza) and educating primary care clinicians on symptoms compatible with avian influenza infections. As a precaution, in early 2024 the Ministry of Agriculture, Forestry and Fisheries of Japan announced that 50,000 birds were culled in Central Japan, and 14,000 birds in the southern Japanese prefecture of Kagoshima were culled after the confirmation of avian influenza outbreaks in both locations. In June 2024, the U.S. CDC recommended that those who had direct contact with birds or other animals infected with avian influenza A virus and become sick within 10 days should isolate at home away from their household members and should not go to work or school until they are proven not to have avian influenza. Border-control measures were implemented in Singapore on 29 April 2024 by the National Parks Board (NParks) and the Animal and Veterinary Service (AVS) with a temporary ban on the importation of poultry and poultry products from Gifu prefecture after an outbreak of highly pathogenic avian influenza (HPAI) in poultry in Chiba prefecture, Japan. The AVS also requires countries exporting poultry, poultry products, and eggs to Singapore to be free from highly pathogenic avian influenza A(HPAI) and H5/H7 low pathogenicity avian influenza (LPAI). While the WHO did not advise any traveller screening for avian influenza at the time of writing of this report, WOAH recommends that any import risk management should be scientifically justified.

Pharmaceutical measures used as part of public health strategies

Vaccinations in animals against avian influenza was the primary pharmaceutical measure identified in international jurisdictions. The WHO Global Influenza Surveillance and Response System (GISRS) in collaboration with the FAO and WOAH maintain a database of candidate vaccines (including regular genetic and antigenic characterization of contemporary zoonotic influenza viruses), which was last updated on 23 May 2024. WOAH recommends that poultry vaccination should be considered as a core measure as an avian influenza control strategy. France took the proactive step of developing a vaccination plan for poultry that is financed by the state and professionals. As of 28 June 2024, a total of 41,631,784 ducks have been vaccinated against the avian influenza A(H5N1) virus in France. In addition to this, as of 16 January 2024, no new outbreaks in livestock have been detected in France, with only 10 outbreaks confirmed in farmed birds for the 2023–2024 season. In New Zealand, a controlled trial of the Poulvac Flufend RG vaccine for five endangered native bird species has been approved. In the U.S., free-flying condors in California are being vaccinated against HPAI as part of a conservation strategy managed by the U.S. Fish and Wildlife Service's Incidence Command Team, and as of 2 February 2024, 94 condors have been vaccinated with at least the initial does of a two-dose vaccine series. Finally, while the U.K. is not vaccinating poultry or captive birds against avian influenza, some zoo birds in England can get authorization for vaccination.

In terms of antiviral usage and vaccinations in humans, the Ministry of Health of Singapore reported treatment for human infection with the bird flu virus varies based on symptoms and that recent A(H5N1) viruses are susceptible to oseltamivir. However, there are reports of resistance to the M2 inhibitors (amantadine and rimantadine). Public health strategies for avian influenza recommended by the Australian Centre for Disease Control includes annual seasonal flu vaccination recommendations and maintaining a strategic stockpile of pandemic vaccines and antivirals. In the U.S., the CDC that symptomatic people with bird or other animal exposures should be treated with antiviral treatment (oseltamivir) while awaiting laboratory results or with chemoprophylaxis, which can be considered for any individual meeting epidemiologic exposure criteria. The U.S. government is developing vaccines against avian influenza A(H5N1) in case they are needed.

Surveillance and monitoring

Internationally, situation reports on the state of avian influenza spread around the world are issued regularly by WOAH, with the most recent update covering 5 to 21 June 2024. The WHO also provides regular risk assessments of the influenza at the human-animal interface situation, with the latest WHO Influenza at the Human-Animal Interface report summarizing findings from member states on new human infections, circulation of influenza viruses in animals, and the overall public health risk from known influenza viruses between 4 May to 7 June 2024. PAHO released an epidemiological update of A(H5N1) on 20 March 2024 and on 5 June 2024, where they encouraged member states to continue implementing surveillance protocols, review their pandemic influenza preparedness and readiness plans, and collaboratively share results from epidemiological and virological investigations. PAHO also released a public health risk assessment of the spread of avian influenza A(H5N1) clade 2.3.4.4b on 12 July 2024 indicating that the overall risk to the public is low. In Brazil, the Ministry of Agriculture and Livestock, which monitors and records avian influenza outbreaks in the country, declared an animal health emergency for 180 days on 22 May 2023, and subsequently extended it for another 180 days after 139 outbreaks were identified. The U.K. has developed a mitigation strategy for avian influenza in wild birds in England and in Wales (last updated 18 March 2024) whereby virologists and epidemiologists collaborate with colleagues to share data on outbreaks in poultry, captive birds and those found in wild birds. In the U.K., the Animal and Plant Health Agency carries out year-round surveillance for avian influenza in dead wild birds and mammals through the routine testing of animals found dead. Finally, in the U.S., as of 28 June 2024, the FDA has continued a step-wise approach to scientific analysis of commercial milk safety, which included testing the efficacy of 297 retail dairy samples (all of which have been negative for the live A(H5N1) virus). On 6 June 2024, the FDA issued an open letter to state-level regulators asking them to monitor dairy cattle herds for signs of illness that would indicate infection with A(H5N1) and implement a surveillance testing program in the state to identify the presence of A(H5N1) virus in dairy herds that might be engaged in producing raw milk for intrastate scale. The CDC and USDA are undertaking widespread

monitoring, which includes case reporting, public health laboratory monitoring, clinical laboratory trends, emergency department trends, and wastewater surveillance.

Canadian jurisdictions

Information and education provision

Within Canada, PHAC provides guidelines on handling wildlife to protect health for hunters, people who work with wildlife, and members of the public, as well as guidance on human health issues and information for health professionals and the public about avian influenza A(H5N1) transmission, symptoms, and treatment on their website. The CFIA provides national biosecurity standards, protocols, and strategies for those in the poultry and dairy service industry as well as information to the public on their website on facts about avian influenza. Most provinces provide information on the signs, transmission, and prevention measures of avian influenza in poultry on their provincial health ministry's website. The CWHC also has a dashboard where it displays suspected and confirmed cases of A(H5Nx) infections in wildlife.

Non-pharmaceutical measures to prevent infection

In terms of non-pharmaceutical measures taken within Canadian provinces and territories, PHAC outlines specific recommendations for infection prevention for individuals involved in avian influenza outbreak situations, including avoiding touching of the face and mucous membranes, cleaning hands frequently, and wearing personal protective equipment. Most provincial and territorial governments provide non-pharmaceutical recommendations for those exposed to or handling birds or other wildlife and those living in or having travelled to an area with A(H5N1), including British Columbia, Alberta, Manitoba, Saskatchewan, Ontario, Quebec, New Brunswick, Prince Edward Island, Yukon, and Nunavut. The CFIA's national biosecurity standards recommend implementing the principles of assessing the biosecurity risks, developing a biosecurity plan that addresses risks, implementing biosecurity measures, monitoring flock health and gathering disease and pest information, and reassessing risks. Some of the recommendations include having proper hand hygiene, using personal protective equipment, avoiding the use and consumption of raw milk products, avoiding surfaces with bird dropping, properly cooking dishes with poultry and eggs, and implementing strict biosecurity measures in livestock holdings. Biosecurity recommendations for commercial poultry flocks from the Ontario government include measures that ensure both exclusion and containment access management, health management, and operational management of flocks. The Animal Health and Biosecurity Program in Saskatchewan aims to increase participation in biosecurity and animal welfare initiatives by promoting industry standards and certification (i.e., meeting recognized benchmarks), improving producer knowledge about biosecurity and animal welfare requirements, and implementing better practices through education, expert assessments, audits, and equipment funding.

Non-pharmaceutical measures to control spread

For animal health response within Canada, cattle producers, consumers, and veterinarians in Canada are advised to report any suspected detection of HPAI infection in animals to the CFIA. The CFIA continues to support provinces, territories and industry in managing disease outbreaks in animals. For example, in response to an A(H5N1) outbreak detected 19 February 2024 at a commercial poultry operation in Mountain View County, Alberta, CFIA declared a primary control zone around the poultry farm, preventing the movement of birds, their products, and by-products as well as things exposed to the birds into, out of, within, or through the zone without permission from the agency. To manage human contacts after exposure to avian influenza in the community, PHAC recommends that public health authorities actively monitor contacts, evaluate contacts for antiviral prophylaxis and/or immunization, and implement measures to reduce the risk of spread. In terms of border measures, as of 29 April 2024, CFIA requires an addendum to the export certificate of cattle imported from the U.S. that certifies that the lactating dairy cows have tested negative by PCR for influenza A virus at a Canadian Animal Health Laboratory Network laboratory, have not been in a location where HPAI has been detected during the 60

days prior to exportation, and if they tested positive for influenza A virus, have completed a 60-day waiting period and have re-tested negative.

Pharmaceutical measures used as part of public health strategies

In terms of public health strategies that use pharmaceutical measures, PHAC's guidance document on human health issues related to avian influenza described high-level recommendations for the use of antivirals for the treatment of avian influenza, including oseltamivir for treatment and post-exposure prophylaxis in individuals over one year of age after close contact with an infected individual. According to PHAC, while there are no widely available influenza A(H5N1) vaccines for public use in Canada, the decision to use a targeted vaccine for H5 influenza on individuals in Canada would depend on the risk of infection during an outbreak.

Surveillance and reporting

The CFIA in collaboration with Health Canada and PHAC has been proactively testing commercial milk samples across Canada to detect fragments of the virus. As of 16 July 2024, all tested samples have been negative for fragments of HPAI A(H5N1).

According to the CFIA, as of 15 July 2024 over 11 million domestic birds were estimated to have been affected by HPAI throughout the current outbreak of A(H5N1) in poultry in Canada since December 2021. Estimates of the number of birds in infected flocks are provided for each province. In addition, Manitoba's Small Flock Avian Influence Program and the Saskatchewan Small Flock Poultry Surveillance Program allow small flock owners to submit dead birds for testing in the presence of potential signs of avian influenza. The CWHC, CFIA, and ECCC maintain a dashboard that displays suspected and confirmed cased of HPAI in wildlife in Canada that can be filtered by province and species. Between January 2022 and July 2024, over 3,000 suspected and confirmed positive wildlife cases were reported in Canada across both birds and mammals. Additionally, the ECCC and CWHC conduct regular avian influenza surveillance in wild birds by participating in the National Inter-Agency Wild Bird Influenza Survey and prioritizing investigations and collections based on strategic importance. The Yukon government's site encourages civilian reporting of potential cases in live birds through the TIPP system (Turn in Poachers and Polluters) and provides contact information of the Yukon's Animal Health Unit.

Next steps

Several gaps exist in the existing evidence syntheses and jurisdictional scans about public health strategies to prevent, reduce and/or mitigate avian influenza spillover to humans that could be the focus of future evidence syntheses and jurisdictional scans. These include:

- One Health approaches that focus on human, animal, and environmental health
- non-pharmaceutical measures used globally to prevent and control the spread of avian influenza infections in humans and animals
- public health measures that are specifically tailored to priority populations that are at higher risk of exposure to avian influenza (e.g., commercial farm workers)
- variations in immune response in humans and animals because of influenza vaccinations
- additional pharmaceutical and non-pharmaceutical measures being taken within provinces and territories in Canada to control the spread of avian influenza.

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